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Eugene Pintard Bicknell (1859-1925)

JOHN HENDLEY BARNHART

(WITH PORTRAIT)

The death of Eugene P. Bicknell, at his home at Hewlett, Long Island, on February 9, 1925, marks the passing of one of the most careful observers among American amateur botanists. Throughout his active career, he was engaged primarily in banking, yet from the number and value of his contributions to botanical literature one might reasonably have inferred that he was by profession a scientific worker.

Eugene Pintard Bicknell was born September 23, 1859, at Riverdale-on-Hudson, then in Westchester County but long since swallowed up by the expansion of the City of New York. Through his father, Joseph Inglis Bicknell, he was descended from Zachary Bicknell, who settled at Weymouth, Massachusetts, in 1635, and from Gregory Dexter, who settled in Rhode Island in 1643 and was president of Providence and Warwick in 1653–54. His paternal grandmother, Emeline Valeria Pintard Inglis of Philadelphia, came from the old Pintard family of Monmouth County, New Jersey, whose progenitor, Anthony Pintard the Huguenot settler of 1691, was a benefactor of the old French Church of New York. Through his mother, Maria Theresa Pierrepont, he was descended from Sir Robert de Pierrepont, who fought at the battle of Hastings in 1066, and Rev. James Pierpont, who was more than any other man actively concerned in the establishment of Yale College. He was also related to the Jay, McVicar, and other well-known old New York families, and was a member of various patriotic societies, such

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as the St. Nicholas Society, the Huguenot Society, the Sons of the Revolution, and the Society of Colonial Wars.

He was a very modest man, always reticent concerning himself, and the writer, although enjoying his acquaintance for more than thirty years, is not well informed concerning the details of his life-history. He was not a college graduate, yet it is evident from his early scientific papers, published several years before he attained his majority, that his education was a thorough one. He was long connected with the firm of John Munroe & Company, foreign bankers of New York City, and was eventually a partner in that firm as well as the affiliated Munroe & Cie., of Paris. After many years of bachelorhood, he married Edith Babcock, at Riverdale-on-Hudson, October 9, 1901, and they had two daughters, Eleanor Franklin, who, after two years with the class of 1926 at Vassar College, gave up her course to be with her father but has been transferred to Teachers College, Columbia University, and Edith Evelyn, a freshman at Vassar. His home had always been at Riverdale, but soon after his marriage he settled in southwestern Nassau County, where he lived the rest of his life.

But it is with his career as a scientist that we are chiefly concerned. His interest in birds and flowers began early, and he was then more ornithologist than botanist. His first technical published paper was on "Evidences of the Carolinian fauna in the lower Hudson Valley." This was published in the Bulletin of the Nuttall Ornithological Club in 1878, when he was only eighteen years old, and was followed by several others before his first contribution to botanical literature. In the same year, 1878, he was one of the group of ten naturalists who organized the Linnaean Society of New York, and he was the president of this society from 1879 to 1887. It was during his presidency that this society published its two volumes of Transactions, and in the first of these appeared one of the most important of his earlier scientific papers, "A review of the summer birds of a part of the Catskill Mountains, with prefatory remarks on the faunal and floral features of the region." While this was based chiefly upon his own observations, he also made use of the notes of others, among these being his brothers Pierrepont Constable Bicknell and George Augustus Bicknell. He was one of the founders, and a life fellow, of the American Ornithologists' Union.

It was at the meeting of January 13, 1880, that Eugene P. Bicknell was elected to membership in the Torrey Botanical Club, and in the club's Bulletin for May of that year appeared his first botanical papers. These were the first of fifty-seven contributions from his pen to the pages of the Bulletin of the Torrey Botanical Club, the last in 1919.

In 1894, students of the local flora of the vicinity of New York were startled by a paper in the Bulletin, which called attention to the fact that there were two species of *Helianthemum* in this region, both well known but always hitherto confused with each other. This was followed in quick succession during the two following years by others on *Sanicula*, *Sisyrinchium*, *Scrophularia*, and *Agrimonia*. Local botanists began to rub their eyes, and wonder whether they were themselves blind, or Bicknell was possessed of abnormally acute vision. His descriptions were so clear that it was easy for anyone else to convince himself of the accuracy of the newly-published observations, and the reputation of E. P. Bicknell was securely established as one of the most discriminating of observers.

His interest in *Sisyrinchium* led him to careful study of material from all parts of the United States, resulting in a series of ten papers devoted to this genus. Later he became particularly interested in the flora of the island of Nantucket, which he had visited in 1889 and 1899, and where he spent as much of his time as he could spare from business from 1904 to 1912. This resulted in a flora of Nantucket, printed in the Bulletin of the Torrey Botanical Club in twenty instalments from 1908 to 1919. This flora contains, incidentally, his principal published references to his earlier collections at York Harbor and Mount Desert, Maine.

In 1896, he became an annual member of the newly organized New York Botanical Garden, his name appearing in the first printed list; and in the same year he was elected a corresponding member of the Philadelphia Botanical Club, organized five years earlier. He was a member of the corporation of The New York Botanical Garden from 1910 until his death, and a member of the board of scientific directors from April 24, 1913, to January 8, 1923, when his resignation on account of ill-health was accepted by the board of managers. His last contribution to botanical literature seems to have been the text accompanying the plate

(no. 205) of *Hypopitys insignata* in Addisonia, in 1921. Although his health had been failing for several years, news of his death came as a surprise to his botanical friends.

The accompanying portrait is from a photograph taken in December, 1910. The appended bibliography is believed to be nearly or quite complete. Mrs. Bicknell has presented her husband's extensive plant collections and botanical books to the New York Botanical Garden.

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Botrychium lanuginosum and its relation to the problem of the fertile spike

M. A. CHRYSLER

(WITH PLATE 4)

In an earlier paper (**3**) the writer discussed the morphological nature of the fertile spike in the Ophioglossaceae, and reached the conclusion that the evidence at hand supported one of the suggestions of Roeper (**6**) to the effect that the fertile spike represents two fused pinnae, namely the basal ones of the leaf, the rest of the pinnae being sterile. The evidence advanced by the writer to support this view indicated that the vascular supply of the fertile spike of *Botrychium* arises precisely like that of any pair of the sterile leaflets. Additional evidence was furnished by certain abnormal specimens of *B. obliquum* Muhl. which showed two or more fertile spikes; the vascular supply of the spikes in these specimens was found to be in accord with the theory of Roeper.

The writer's excuse for reopening the discussion at this time is the "discovery" of a number of herbarium sheets of a species of *Botrychium* which appears to have been overlooked but which offers very definite evidence on the question of the nature of the fertile spike in the genus under consideration. This species is *B. lanuginosum* Wall. (at one time not separated from *B. virginianum*), a plant occurring in southeastern Asia, generally at high altitudes. Although the species takes its name from the "lanugo" or long silky hairs which scantily cover the leaves, the most striking feature is the position of the sporogenous portion. While this plant is undoubtedly a *Botrychium*, most specimens do not show what could properly be called a fertile spike, but present the appearance of having the second, third or higher leaflet function as the fertile or sporogenous organ. Twenty-four specimens have been examined, through the kindness of the curators of the Gray Herbarium, Missouri Botanical Garden, New York Botanical Garden, and United States National Herbarium, and in these specimens the fertile part occupies the position of the second, third, fourth, fifth, or sixth leaflet, with a decided preponderance in the class of the third leaflet. FIG. 1,

from a specimen kindly loaned by the Curator of the Herbarium of the Missouri Botanical Garden, clearly shows the fertile part occupying the position of the third leaflet. Although in this specimen the leaflets are disposed alternately, cases are not lacking where most of the leaflets are opposite, as is shown in FIG. 2, a photograph of sheet 776,951 of the National Herbarium. This interesting specimen has leaflets 1 and 2 opposite, 3 and 4 opposite, then the fertile spike which here appears to represent two fused leaflets, followed by sterile leaflets arranged in pairs for the most part.

Through the marked kindness of the Curator of the Gray Herbarium, a specimen closely resembling the one just described has been available for microscopic study. The critical region of the leaf has been swelled out by means of hot dilute ammonia, imbedded in paraffin and made into serial sections. From these it is perfectly clear (1) that the fertile spike has a double vascular supply, in contrast to the single vascular supply of the sterile leaflets, and (2) that each half of the vascular supply of the fertile spike is attached to the leaf trace of the rachis exactly as is the single trace from each sterile pinna, and precisely as has been described by the writer for *B. virginianum* (**3**, p. 3), that is, each pinna trace joins the C-shaped trace of the rachis near one edge of the latter, subtending a narrow pinna-gap. This condition has been shown (*l.c.*) to correspond to what may be seen in the leaves of such primitive ferns as *Osmunda* and *Todea*. It is safe to conclude that the fertile spike of the specimen represented in FIG. 2 consists likewise of two fused pinnae. Although no material of plants like FIG. 1 has been available for sectioning, it may be confidently predicted that the fertile spike of such cases will show a single trace attached to the trace of the rachis in the same manner as is the trace of a sterile pinna.

It is obvious that *B. lanuginosum* is a very variable species. According to Bitter (**1**, p. 471) it is perhaps second only to *B. Lunaria* in this respect, showing variability not only in size, in position of the fertile spike and in arrangement of the pinnae, but also in the not infrequent occurrence of a second smaller fertile spike farther up on the leaf than the first spike. This feature is not represented in the specimens to which I have had access, but is realized in a specimen of *B. ramosum* (Roth.) Aschers., represented in FIG. 3, collected at Fairlee, Vermont, by Dr. H. M.

Denslow and deposited in the Herbarium of the Brooklyn Botanic Garden, the Director of which institution has kindly furnished the photograph. This specimen not only shows an extra pair of fertile spikes, but displays a forking of the large fertile spike which reminds one of the cases already described by the author (**3**) in which the fertile spike of *B. obtiguum* is either forked or else divided all the way to the base. Reference may also be made to *figure 25* of the author's earlier paper (**3**), showing one of the pinnae of *B. obliquum* developed as a fertile organ, a condition which has been observed in several species and is figured for *B. Lunaria* by Goebel (**5**). Another variable feature of *B. lanuginosum* mentioned by Bitter (*l.c.*) is the not infrequent occurrence of a few sporangia on the edges of sterile leaflets, a condition also observed by Goebel (**5**) in *B. Lunaria*.

The genus *Aneimia* has already been referred to as a case where the two basal pinnae of each leaf are specialized as the spore-bearing part and turn sharply upward (see *fig. 23* of **3**). It is interesting to note that in this genus there are species where a single fertile spike or leaflet takes the place of the usual pair. The herbarium of the New York Botanical Garden contains six specimens of a plant labelled "*Ornithopteris* sp. nov.?, Santa Marta, U. S. of Colombia, col. Herbert H. Smith 1898–9." In each of these specimens a single fertile spike arises at the base of the green region of the leaf, apparently in the adaxial position, after the manner of a typical *Botrychium*. The same condition is shown by *Aneimia Wrightii* Baker, a rare little fern collected by the indefatigable Wright in eastern Cuba in 1859–60. Whether the fertile spike in these cases represents a single pinna or a fusion of two basal pinnae is not possible to make out from the herbarium sheets, but the general resemblance to what seems to have happened in *Botrychium* is exceedingly suggestive.

In attempting to fit the Botrychiums into their place it may be well to recall that, beginning with the generalized type of fern leaf in which each leaf bears spores on all of its branches, localization of the area of spore-production in fern leaves has proceeded in two ways:

(1) The leaves of the current season show a greater or less differentiation into vegetative and reproductive organs. This method of effecting division of labor, the so-called heterophylly, shows many gradations and is widespread. Familiar examples

are *Lorinseria areolata* (L.) Underw. (= *Woodwardia angustifolia* Sm.), *Struthiopteris germanica* Willd., and *Osmunda cinnamomea* L.

(2) The differentiation appears in individual leaves—

(*a*) Only the tip region is fertile, e. g., *Polystichum acrostichoides* (Michx.) Scott, *Osmunda regalis* L.

(*b*) Only the median region is fertile, e.g., *Osmunda Claytoniana* L., *Botrychium lanuginosum* Wall.

(*c*) Only the basal region is fertile, e.g., *Aneimia* spp. In this genus the fertile pinnae are raised into a favorable position. Most species of *Botrychium* appear to belong in this class, and show the specialization carried to a high degree by fusion of the two basal pinnae as well as by being raised into an erect position.

That the genus *Botrychium* is a highly specialized one is indicated by certain features which have been reported for *B. virginianum:* a well marked cambium in the stem, the symbiotic subterranean gametophyte, the production of only one (or two) leaves per season, with the primordia of others early laid down. At the same time there is foundation for the view that the family has branched off from the main fern stock at a comparatively low level; this appears to be the mature judgment of Bower (**2**, p. 294) who suggests Osmundaceae and Botryopterideae as the probable nearest relatives.

On account of the generalized and plastic nature of *Botrychium lanuginosum*, as brought out in the foregoing account, it may be suggested that in this species we see more nearly than in the other species what the ancestral *Botrychium* looked like, namely, a fern in whose leaf spore production was restricted to one or two pinnae occupying no special region of the leaf (FIG. 1). Individuals occurred in which the leaflets were opposite rather than alternate; two opposite fertile leaflets became fused (FIG. 2). Finally the location of the fertile leaflets became fixed at the level of the basal pair (seen in the closely related *B. virginianum*).

The uncovering of *B. lanuginosum* provides exactly the sort of evidence which was lacking at the time of the writer's earlier studies on Ophioglossaceae; this species almost constitutes a living fossil *Botrychium*, much as the megasporophyll of *Cycas revoluta* has been styled a living fossil cycad. There now appears to be no reasonable doubt that the fertile spike of the common species of *Botrychium* represents a fused pair of pinnae, namely

the basal pair. Such a view of course precludes the possibility of a strobilar origin of the aerial organ of Ophioglossaceae. In fact the opinion may be ventured that if Bower had been acquainted with *B. lanuginosum* he would scarcely have advanced the theory of a strobilar origin for the group, a view which he has relinquished (2) upon the basis of evidence derived from all aspects of the question. Moreover, upon the basis of the accumulated evidence, there would seem to be no more reason for retaining the order Ophioglossales than for framing an order for the Osmundaceae; in other words, the family Ophioglossaceae should be placed in Filicales rather than in a separate order.

RUTGERS UNIVERSITY,
NEW BRUNSWICK, NEW JERSEY

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4. **Chrysler, M. A.** Is *Ophioglossum palmatum* anomalous? Bot. Gaz. **52:** 151–153. 1911.
5. **Goebel, K.** Organographie der Pflanzen. Jena, 1901.
6. **Roeper, J.** Zur Systematik und Naturgeschichte der Ophioglosseae. Bot. Zeit. **17:** 241–246, 249–254, 257–262, 265–268. *pl. 12.* 1859.

Description of plate 4

FIG. 1. Botrychium lanuginosum Wall., from sheet no. 1602 of the Missouri Botanical Garden (reduced).

FIG. 2. Botrychium (species not assigned, but probably *B. lanuginosum*) from sheet no. 776,951 of the U. S. National Herbarium.

FIG. 3. Botrychium ramosum (Roth) Aschers., abnormal specimen in the herbarium of the Brooklyn Botanic Garden.

CHRYSLER ON BOTRYCHIUM LANUGINOSUM

UNIV. OF MICH.

Contributions to the flora of Long Island, New York
Third paper*

WILLIAM C. FERGUSON

The plants listed below represent species that, in the writer's experience, are from uncommon to, in some instances, very rare, and were all collected during the season of 1924 while on solitary rambles, with the following exceptions: *Poa bulbosa* was found by Mr. Hal Fullerton of Medford, L. I.; *Carex leucorum*, by the late Mr. Eugene P. Bicknell; *Triosteum aurantiacum*, by Mrs. Asa Wells of Riverhead, L. I.; *Rynchospora cymosa* and *Aster paniculatus*, while with Mr. Norman Taylor of the Brooklyn Botanic Garden.

With the exception of *Fimbristylis puberula*, *Juncus brachycarpus*, *Drymocallis agrimonioides*, *Hottonia inflata*, *Bartonia paniculata*, *Menyanthes trifoliata*, and *Aster acuminatus*, as to the identity of which the writer felt certain, all names were confirmed or corrected by the following authorities:

Grasses by Mrs. Agnes Chase.

Sedges, except *Carex*, by Dr. N. L. Britton.

Carex, except the Montanae group, by Mr. Kenneth K. Mackenzie.

Carex, Montanae group, by Mr. Eugene P. Bicknell.

Cuscuta by Professor T. G. Yuncker.

Aster by Professor Edward S. Burgess.

All others by Dr. J. K. Small, Dr. F. W. Pennell, Professor M. L. Fernald, and Mr. C. A. Weatherby, whose names appear in the text, and to all of whom I wish here to express grateful acknowledgement.

POA BULBOSA L. Riverhead: waste ground. Introduced from Europe.

CHAETOCHLOA GENICULATA (Lam.) Millspaugh & Chase, Field Mus. Publ. Bot. **3**: 37. 1903. Millneck; Merrick; Montauk; salt marshes and bordering meadows. (This is *C. imberbis* of Britton's Manual.)

SCLERIA TRIGLOMERATA Michx. Central Islip: pine barren swamps.

FIMBRISTYLIS PUBERULA (Michx.) Vahl. Hempstead: damp meadow.

RYNCHOSPORA CYMOSA Ell. Montauk: swampy meadow. The writer can find no previous record for Long Island.

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* The previous papers of this series appeared in Torreya **22**: 43-49. 1922, and in Bull. Torrey Club **51**: 177-201. 1924.

SCIRPUS NANUS Spreng. Massapequa: soft mud in salt marsh. Montauk: soft mud shore of Oyster Pond, brackish.

SCIRPUS PLANIFOLIUS Muhl. Wyandanch; Kings Park; Kew Gardens; Deer Park; Port Washington: all localities in dry or rich hilly woods.

? SCIRPUS PALUDOSUS A. Nelson.

The writer cannot separate these small plants with dense, compact inflorescence and growing singly or but few together, from the larger *Scirpus robustus* which grows in dense masses with stout rootstocks. Measurement of the achenes and of the awns on the scales shows no material difference between the two, and Dr. N. L. Britton, to whom the writer has shown the smaller plants, has named them all *S. robustus*. The writer is inclined to believe that these smaller plants are seedlings or, at least, much younger plants than the larger typical specimens of *Scirpus robustus*. If this could be demonstrated, these smaller plants would not even be entitled to varietal rank. These smaller plants are from one to two feet tall. The writer has seen large colonies of *S. robustus* six feet tall or more. It takes time for rootstocks to grow to the size represented in these colonies. It is to be hoped that other botanists will study this subject in the field.

CAREX ABDITA Bicknell, Bull. Torrey Club **35:** 491–2. 1908. Wyandanch; Kings Park; Richmond Hill; Kew Gardens: all in rich or dry hilly woods. Merrick: thicket edge, salt marsh.

CAREX ROSEA Schk. Woodside: very swampy rich woods.

CAREX MITCHELLIANA M. A. Curtis. (See C. A. Weatherby, Rhodora **25:** 17. 1923.) East Moriches: open bog. Montauk: bog near Oyster Pond. Millneck: boggy woods.

CAREX STRIATULA Michx. Queens: rich hilly woods.

CAREX MESOCHOREA Mackenzie, Bull. Torrey Club **37:** 246. 1910. (*C. mediterranea* Mackenzie, Bull. Torrey Club **33:** 441. 1906.) Garden City: grassy village roadside, introduced from further south.

CAREX TRIBULOIDES SANGAMONENSIS Clokey, Rhodora **21:** 84. 1919. Queens: swamp in hilly rich woods.

CAREX LEUCORUM Willd. Enum. Pl. Berol. Suppl. 63. 1809. (Name only.) Enum. Pl. Berol. (ed. 2) **2:** 380. 1822. The earliest application of a varietal name to the plant is *Carex pennsylvanica distans* Peck, Rept. N. Y. State Mus. **46:** 131. 1893.

Valley Stream: border of dry sandy level woods.

CAREX RUGOSPERMA Mackenzie, Bull. Torrey Club **42:** 621. 1915. Kew Gardens: hilly rich woods.

CAREX LAXICULMIS Schwein. × C. ABSCONDITA Mackenzie. Millneck: swampy hilly woods.

CAREX VARIA Muhl. × C. UMBELLATA Schk. Kings Park: dry hilly oak woods.

CAREX ABSCONDITA Mackenzie, Bull. Torrey Club **37:** 244. 1910. (*C. ptychocarpa* of the manuals.) Last year the writer had observed that the swollen distorted perigynia, so characteristic of this species here on Long Island, contained achenes that were oblong, longer and narrower than are the normal achenes, and that these abnormal ones were all split and empty. This season in further investigation of the cause he found a live grub that about completely filled the achene.

JUNCUS BRACHYCARPUS Engelm. Freeport: open bog. The writer can find no previous record for Long Island.

IBIDIUM VERNALE (Engelm. & Gray) House. Merrick: elevation on salt marsh. Determination by Dr. H. M. Denslow.

SALIX VIMINALIS L. Merrick: border of swamp and old clearing. Native of Europe.

POLYGONUM PROLIFICUM (Small) Robinson. Merrick; Massapequa; Amityville; Oyster Bay: all in salt marshes.

POLYGONUM ATLANTICUM (Robinson) Bicknell.

The writer has found a plant with achenes as in *P. atlanticum* and also exserted achenes of various lengths and believes *P. exsertum* Small to be a viviparous condition of *P. atlanticum*. Witmer Stone and Eugene P. Bicknell have published similar opinions.*

SAGINA APETALA Ard. Wading River: shady village roadside.

SAGINA DECUMBENS (Ell.) T. & G. Garden City: shady village roadside.

SAGINA PROCUMBENS L. Montauk: brackish wet shore of Oyster Pond. Plants densely tufted. Determinations of *Sagina* by J. K. Small.

ARABIS LYRATA L. Oyster Bay: damp open hillsides.

CARDAMINE HIRSUTA L. Roslyn: damp open hillside.

DRYMOCALLIS AGRIMONIOIDES (Pursh) Rydb. Meadowbrook: dry gravelly bank.

ERODIUM CICUTARIUM (L.) L'Her. Babylon: grassy field; adventive from Europe.

GERANIUM MOLLE L. Setauket: waste field; adventive from Europe.

VITIS BICOLOR LeConte. Riverhead: roadside thicket.

HOTTONIA INFLATA Ell. Riverhead: small pond on Sound Avenue. Mr. E. S. Miller directed the writer to this locality where he had collected it fifty years ago. Mr. E. P. Bicknell has written the writer that it grows at Hewlett, Long Island.

BARTONIA PANICULATA (Michx.) Robinson. North of Good Ground, in sphagnum in coast cedar swamp.

MENYANTHES TRIFOLIATA L. Water Mill: open swamp. Mr. F. S. Benedict directed the writer to this locality and plant.

CUSCUTA CORYLI Englm. Middle Island: pine barren swamp.

CUSCUTA COMPACTA Juss. Millneck; Massapequa: thicket edge of swampy woods. Queens: rich hilly woods. Merrick: swampy low woods. Southold: open swampy meadow.

CUSCUTA GRONOVII LATIFOLIA Engelm. Southold: open swamp.

CUSCUTA GRONOVII VULGIVAGA Engelm. Millneck: swampy thicket. Massapequa: swamp woods. Merrick: salt marsh. Hempstead: garden.

SCUTELLARIA INTEGRIFOLIA L. Massapequa: damp meadow near salt marsh. Wyandanch: dry hilly woods.

SOLANUM VILLOSUM (L.) Mill. Montauk: sandy shore of brackish Oyster Pond. Point O Woods: ocean sand dunes.

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* Witmer Stone. Plants of southern New Jersey. Rep. N. J. State Mus. **1910**: 425. Eugene P. Bicknell. Flora of Nantucket. Bull. Torrey Club **36**: 450. 1909.

GRATIOLA AUREA forma leucantha Bartlett, Rhodora **9**: 123. 1907. (Flowers white). Sweezytown: shore of small pond. Determined by F. W. Pennell who had no record from our area when he revised *Scrophulariaceae*, and who had never seen it growing. Obviously very rare.

TRIOSTEUM AURANTIACUM Bicknell. Sound Avenue, Riverhead: damp thicket.

LACTUCA FLORIDANA (L.) Gaertn. Port Washington: rich, hilly woods.

HIERACIUM VULGATUM Fries. Oakdale: roadside and fields.

EUPATORIUM ALBUM L. Middle Island: border of pine barren swamp.

SOLIDAGO HISPIDA Muhl. Montauk: hither woods. One colony on dry hilly oak woods growing with *Solidago bicolor*. Comparatively few plants and averaging lower and slenderer than associated *S. bicolor*. The writer can find no previous record for Long Island.

SOLIDAGO RUGOSA SPHAGNOPHILA Graves.

SOLIDAGO ULMIFOLIA Muhl.

In hilly rich woods at Queens the writer found plants that he could not satisfactorily place with either glabrate forms of *S. rugosa*, or with *S. ulmifolia*, and sent them to Professor M. L. Fernald, who with Mr. C. A. Weatherby at the Gray Herbarium, determined them as probably hybrids or intermediate forms of *Solidago ulmifolia* Muhl. and *Solidago rugosa sphagnophila* Graves.

ASTER ACUMINATUS Michx. Montauk: hilly rich woods.

ASTER IANTHINUS Burgess. In Gray's Manual, 7th ed. (p. 805), this species, with the two following included as synonyms, is made a variety of *Aster macrophyllus* L. Plattsdale: hilly rich woods. Massapequa: dry level oak woods.

ASTER MULTIFORMIS Burgess. Plattsdale: hilly rich woods.

ASTER VIOLARIS Burgess. Hempstead Reservoir: bank oak woods.

ASTER MACROPHYLLUS L. Millneck: hilly rich woods.

ASTER SCHREBERI Nees. Plattsdale: hilly rich woods.

ASTER SAGITTIFOLIUS Willd. Douglaston: hilly rich woods.

ASTER SAGITTIFOLIUS DISSITIFLORUS Burgess. Douglaston: hilly woods. The writer can find no previous record of *A. sagittifolius* for Long Island.

ASTER TARDIFLORUS L. (*A. patulus* Lam). Millneck: hilly rich woods; single plant. Dr. Burgess is inclined to believe from field experience that this *Aster* is a hybrid.

Intermediate forms between *A. paniculatus* and *A. salicifolius*, *A. paniculatus* and *A. Tradescanti*, *A. salicifolius* and *A. Tradescanti*, *A. tradescanti* and *A. vimineus*, *A. Tradescanti* and *A. lateriflorus*, *A. lateriflorus* and *A. vimineus*, are not uncommon on Long Island. The writer this season has found all of these forms. His determinations have been verified or corrected by Dr. E. S. Burgess.

Chomelia, Jacquin and Anisomeris, Presl

H. H. Rusby

(WITH TWO TEXT-FIGURES)

The genus *Chomelia* of the Rubiaceae was founded by Jacquin on *C. spinosa* (Select. Stirp. Amer. Hist. 18. *pl. 13.* 1763). The genus *Anisomeris* was founded by Presl on *A. spinosa* (Symb. Bot. **2**: 5. *pl. 54.* 1833). Subsequent authors, assuming erroneously that the two genera were identical, have concerned themselves with the question as to which name is correct. The name *Chomelia* had been used by Linné in 1737, in a different connection, hence some authors hold that Jacquin's name is untenable, and Otto Kuntze (Rev. Gen. Pl. **1**: 277. 1891) proposed *Caruelina* to replace it, rejecting *Anisomeris*, apparently because there was an *Anisomera*. Under rules now generally accepted, both of these objections fail, since Linné abandoned his name *Chomelia* in 1753, and no other author appears to have used it between that date and the time of its proposal by Jacquin. This leaves Jacquin's name to stand for all species having the generic characters pertaining to *C. spinosa*. Both of the essential characters of this genus are perfectly displayed in Jacquin's picture, though scarcely referred to in his description. They are (1) the possession of dorsal horns or awns by the corolla-lobes; (2) a characteristically sagittate anther. In all the species of which I have been able to examine specimens or figures, these two characters are associated, or both are wanting. The study of descriptions is of little avail, as nearly all authors have either overlooked or ignored these characters, which are not referred to in their descriptions. The present article, therefore, can enumerate only the few species whose characters I have thus been able to establish.

There is not the slightest difficulty in determinating the affinity of any species if a well-developed bud can be seen, as the four corolla-lobes of *Chomelia* are concave, usually with their tips inflexed, and bear vertical, mostly hollow awns or horns, which stand free and separate, as a sort of crown to the bud. Some authors have described these lobes as "acuminate," but they are not really so. In fact, I have seen no member of either

genus that has acuminate corolla-lobes. It is the dorsal horns which have been mistaken for terminal acuminations. The slightest manifestations of these horns that I have seen is in *C. Pohliana* Muell.-Arg., figured in Martius' Flora of Brazil. In this species, they are mere hollow conical protuberances at the end of the bud. In the next succeeding plate (*C. ribesioides* Muell.-Arg.) there is no trace of such appendages, and it seems strange that this character should have been overlooked at that time. It appears still more strange that it should have been overlooked in Jacquin's figure, which shows almost the extreme degree of development of these awns.

In one or two species, the tip of the corolla-lobe is almost obsolete, so that the appendage is almost continuous with the end of the lobe.

The difference in the anthers is quite as striking. Jacquin's figure shows strongly sagittate anthers, with the basal lobes acuminate. In some species this acumination is extreme, reaching the state of attenuation. Presl's figure of *Anisomeris* does not show the anthers, but I have examined enough species to show that, with naked corolla-lobes, there is always an anther with the thecae parallel and contiguous to their short, obtuse bases.

The species of the two genera, so far as I have been able to determine them, are as follows:

CHOMELIA Jacqin

1. C. SPINOSA Jacq. Select. Stirp. Amer. Hist. 18. *pl. 13*. 1763.

2. C. POHLIANA Muell.-Arg. Flora **58**: 452. 1875. (*Anisomeris Pohliana* Chodat & Hassl. Bull. Herb. Boiss. II. **4**: 175. 1904.)

3. **C. Purpusii** (Brandegee) n. comb. (*Anisomeris Purpusii* Brandegee, Univ. Calif. Publ. Bot. **6**: 70. 1914.)

Gleason's *no. 295*, from "dense upland forest, Tumatumari, British Guiana," is said by N. E. Browne to be "near *C. tenuiflora* Benth.," to which species Standley refers it. Gleason's plant is a *Chomelia*, with the corolla-appendages stout, brown and indurated and with the basal lobes of the anthers rather short, the anthers projecting beyond the mouth of the corolla.

The following species appear not to have been published:

4. **Chomelia longicaudata** n. sp. (*C. brachyloba* Standley, Contr. U. S. Nat. Herb. **18:** 136, in part. 1916.) Pilose with mostly appressed gray hairs. Branchlets short, slender, crowded, leafy. Stipules 3 to 5 mm. long, setaceous, acute. Petioles 5 to 7 mm. long. Blades 3 to 7 cm. long, 2 to 3 cm. broad, oval and somewhat rhomboidal, abruptly contracted at both ends, especially at the base, acute, entire, thin, drying brownish, the upper surface sparsely strigose, the lower densely so, with midrib and secondaries sharply prominent, the secondaries 8 or 10 on a side, strongly falcate-ascending. Peduncles axillary, mostly solitary, slender, about 2 cm. long, slightly thickened toward the summit, where the sessile flowers are crowded in a cyme that is

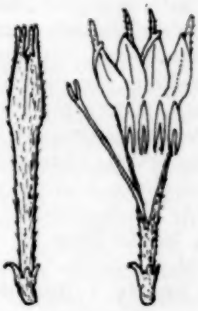

FIG. 1. (× 2)
C. longicaudata.

FIG. 2. (× 2)
C. brevicornu.

usually shortly bifid. Bud densely white-strigose, the horns conspicuous. Calyx-tube infundibular, about 2 mm. long, the limb campanulate, short, purplish, the teeth thick and rigid, somewhat spreading, acute, unequal, the longest 1.25 mm. long. Corolla tube 12 to 15 mm. long, very slender, slightly broadened toward the summit. Lobes widely spreading, oval, 3 or 4 mm. long, exclusive of the horn, which is sometimes a third as long, slender. Anthers attached at the summit of the tube, extending beyond the base of the lobes, sessile, sagittate, the lobes acuminate, about as long as the body. Style exserted, the lobes oblong, nearly 1 mm. long. FIG. 1.

Standley's *C. brachyloba* is based on Pittier's Central American specimen, which is an *Anisomeris*, and is transferred to this genus below, this leaving Smith's *Chomelia* without a name, unless we were to hold that the specific name *brachyloba* must apply to both species, in the different genera. This seems untenable, and tending to confusion. Smith's *no. 392*, therefore, collected near Santa Marta, Colombia, 1898–1899, and deposited in the her-

barium of the New York Botanical Garden, is made the type of *C. longicaudata*.

5. **Chomelia brevicornu** n. sp. Coarsely short-pilose with gray hairs. Branchlets elongated, rather slender, gray, terete. Spines axillary or slightly supra-axillary, stout, pungent, gray, 1 to 2 cm. long. Stipules 8 to 10 mm. long, broadly triangular, acuminate and acute, pilose. Petioles 1 to 2 cm. long, broad. Blades to 8 or 9 cm. long and 4 cm. broad, very unequal, ovate, abruptly acuminate and acute at both ends, entire, drying brown, nearly glabrous above, except on the principal veins, which are lightly ferruginous-hairy and lightly impressed, more hairy beneath, where the midrib and secondaries are strong and prominent, the latter about 8 or 10 on each side, strongly ascending and lightly curved, the venation very finely and lightly anastomosing. Cymes long-peduncled, densely flowered at the summit, the flowers sessile. Bractlets about equalling the calyx, thick and rigid, obtuse. Calyx-tube cylindrical, 1.5 mm. long, 1 mm. thick, a little shorter than the limb, which is deeply divided, the 4 teeth thick and rigid, somewhat recurved, obtusish. Corolla nearly 2 cm. long, the teeth 4 or 5 mm. long, oblong, obtuse, the dorsal awn short, stout and rigid, dark colored. Anthers linear, nearly 3 mm. long, extending to the base of the corolla-lobes, attached at about the middle of the back. Style filiform, exceeding the anthers, the stigmas nearly 1 mm. long, erect, obtuse, oblong. FIG. 2.

Type collected by the author at Rurrenabaque, Prov. Beni, Bolivia, altitude 1000 feet, October 15, 1921 (Mulford Explor. *no. 1282*) and deposited in the herbarium of the New York Botanical Garden.

"A small tree with white flowers, in second growth of forest."

6. **Chomelia dimorpha** n. sp. Young portions, veins of the lower leaf surfaces etc., appressed pubescent. Branchlets slender and weak, gray. Spines short, gray. Stipules nearly 1 cm. long, 2 mm. wide, lanceolate with attenuate summit, broadly keeled. Petioles 3 to 5 mm. long, stout. Blades up to 1 dm. long and 4 cm. broad, ovate, with obtuse base and acuminate and acute summit, entire, thin, nearly glabrous above, the pubescent reddish midrib and secondaries sharply prominent beneath, the latter about 12 on a side, strongly ascending. Cymes axillary, mostly solitary, shortly peduncled, densely flowered, the flowers of two kinds. Calyx of the normal flowers 2.5 mm. long, urceolate-campanulate, the teeth little more than a fourth of the length, sub-equal, nearly erect, acute. Corolla-tube 6 mm. long, regularly cylindrical, the limb 5 mm. long, divided nearly to the base, the tips of the lobes nearly obsolete, the appendages obtusish. Anthers 2 mm. long, very slender,

acuminate, extending a little beyond the base of the corolla-lobes, the attenuate basal lobes about a third of the length. Stigmas reaching beyond the middle of the corolla-lobes, erect, linear-oblong, nearly as long as the anthers.

Associated with these flowers are a few with corollas only 2 or 3 mm. long, the lobes as long as the tube, the anthers stouter and better developed, and the flowers apparently quite perfect.

Type collected by O. Buchtien (*no. 206*) at Coroico, Yungas, Prov. La Paz, Bolivia, altitude 1100 meters, Oct. and Nov. 1912, and deposited in the herbarium of the New York Botanical Garden.

Species very near *C. brevicornu*, but distinguished by the character of the branchlets, the indumentum and inflorescence.

7. **Chomelia multiflora** n. sp. Densely and softly pubescent with short, spreading gray hairs. Spines long and slender, very pungent. Flowering branchlets numerous, short. Stipules not seen. Petioles to 5 mm. long, mostly almost obsolete. Blades crowded on the short branchlets, to 5 cm. long and 3 cm. wide, oval, verging to ovate or obovate, with acute base and blunt or acute summit, entire, thickish, drying brown, very minutely short-hairy above, more so beneath, where the midrib and secondaries are prominent, the latter 6 or 8 on a side, slender, strongly falcate. Cymes slenderly peduncled, mostly shorter than the leaves, the flowers numerous, densely crowded. Calyx-tube 1 mm. long, cupulate, the teeth a little longer, very unequal, triangular-ovate, acute, lightly spreading. Corolla-tube 8 mm. long, cylindrical, the lobes 3 mm. long, the appendages thickened and indurated, and almost continuous with the end of the lobe. Anthers attached at the summit of the tube, 2 mm. long, the basal lobes very slender, attenuate, about a third of the length. Style very slender, extending beyond the middle of the corolla-lobe.

Type collected by the author in copses of the pampas near Lake Rogagua, Prov. Beni, Bolivia, altitude 1000 feet, Oct. 28, 1921 (Mulford Explor. *no. 1365*), and deposited in the herbarium of the New York Botanical Garden. "A large shrub, with white flowers."

ANISOMERIS Presl

1. A. SPINOSA Presl, Symb. Bot. **2**: 5. *pl. 54*. 1833. (*Chomelia Anisomeris* Muell.-Arg. Flora **58**: 451. 1875.)

2. **A. Martiana** (Muell.-Arg.) n. comb. (*Chomelia Martiana* Muell.-Arg. *l.c.*) Figured under the name "*C. obtusa*

Cham. & Schlchtd." by Wawra, Bot. Ergebn. Reise Maxim. Bras. 105. *pl. 74.* 1866.

3. **A. ribesioides** (Muell.-Arg.) n. comb. (*Malanea ribesioides* Muell.-Arg. Flora **58:** 453. 1875. *Chomelia ribesioides* Benth.; Mart. Flor. Bras. 6^5**:** 40. *pl. 5.* 1881.)

4. **A. polyantha** (Blake) n. comb. (*Chomelia polyantha* Blake, Contr. U. S. Herb. **20:** 532. 1924.)

5. **A. brachyloba** (Standley) n. comb. (*Chomelia brachyloba* Standley, Contr. U. S. Nat. Herb. **18:** 136. 1916.) Pittier's specimen from Vic. Valencia, Venezuela, labelled as above by Standley, is the only representative of the species seen by me. Smith's specimen, there cited, is a *Chomelia*, described above as *C. longicaudata* n. sp.

6. **A. boliviana** (Standley) n. comb. (*Chomelia boliviana* Standley (*l.c.*). *Chomelia tenuiflora* Benth. ex Rusby Mem. Torrey Club 3^3**:** 45. 1893.)

Gleason's *no. 872*, from banks of the Essequibo River, Blackstone, British Guiana, is a species of *Anisomeris*. N. E. Browne says of it "Very near *C. angustifolia* Benth.," to which species Standley refers it. If this is identical with Bentham's species, the latter must be referred to *Anisomeris*.

COLLEGE OF PHARMACY,
COLUMBIA UNIVERSITY

Notes on Fabaceae—IV

PER AXEL RYDBERG

XYLOPHACOS Rydberg

The genus was originally based on two species, *Astragalus missouriensis* and *A. Shortianus*, of which the latter was regarded as the type. Later the author (Bull. Torrey Club **32**: 661–2. 1906, and **40**: 48–49. 1913) extended the genus to include practically Gray's and Watson's sections ARGOPHYLLI and ERIOCARPI or Sheldon's LANOCARPUS and SERICOPHYLLUS. Dr. Gray, to whom the fruit was unknown, included erroneously *A. Arthur-Schottii* in the former; likewise Watson included *A. pubentissimus* and *A. Beckwithii*. Sheldon misplaced several species, as *A. dorycnioides*, which he had misunderstood, *A. Thompsonae*, which he renamed *A. syrticclus*, *A. triquetrus*, *A. Beckwithii*, *A. artemisiarum*, *A. mokiacensis*, *A. ursinus*, *A. gilensis*, *A. Reverchoni*, and *A. pubentissimus*. I am now inclined to exclude also *A. Parryi* from the genus.

I can not see why Gray (followed by Watson and Sheldon) placed one of his sections in the subgenus *Euastragalus* and the other in the subgenus *Phaca*. Species with the pod more or less sulcate on the lower suture are found in both sections, but none have even a partial partition. The only difference is the pubescence of the pod, and *A. glareosus* and *A. arnophyllus* connect the two groups. Jones in his latest work "Astragalus," united the two sections under ARGOPHYLLI, but erroneously included *A. desperatus* in it.

The genus is characterized by its woody or leathery pod, one-celled and somewhat inflated, without any partition, long cylindric calyx-tube longer than the teeth, comparatively narrow petals, with the claws (except that of the banner) longer than the blades. All the species are perennial with a woody caudex, usually with short stems and most of them with silvery canescent foliage. The genus is wholly North American.

Pod strigose, short-pilose, or glabrous.
  Exocarp of the fruit not spongy; stem evident, but often short.
    Pod more or less curved, or at least decidedly oblique.

Leaves sparingly hairy or glabrous, scarcely canescent.	I. IODANTHI
Leaves densely silvery canescent on both sides.	II. CYANEI
Pod straight or nearly so; leaves silvery.	III. MISSOURIENSES
Exocarp of the fruit spongy at least in age; plant subacaulescent.	IV. PYGMAEI
Pod long-villous.	
Corolla purple or ochroleucous.	
Pubescence of the leaves strictly appressed.	V. ERIOCARPI
Pubescence of the leaves loosely villous.	VI. GLAREOSI
Corolla crimson.	VII. COCCINEI

I. IODANTHI

Calyx more or less black-hairy; pod more or less strigose; leaves strigose or glabrous.	
Leaflets glabrous or sparingly hairy on the margins and veins; pod mottled.	1. *X. iodanthus*
Leaflets strigose beneath; pod not mottled.	
Pod 2.5–4 cm. long, long-acuminate.	2. *X. cibarius*
Pod 2–2.5 cm. long, abruptly acute at each end.	3. *X. cuspidocarpus*
Calyx white-hairy, pod short-pilose or glabrous.	
Leaflets, calyx, and pod short-pilose.	4. *X. puniceus*
Leaflets, at least below, and calyx long-pilose; pod glabrous.	13. *X. iodopetalus*

1. **Xylophacos iodanthus** (S. Wats.) Rydberg. (*Astragalus iodanthus* S. Wats. Bot. King Exp. 70. 1871.)

This species is distinguished from all the rest in the very scant pubescence, and in flower it simulates very closely some species of *Cystium*, as for instance *C. diphysum*. The fruit is narrow and resembles that of *Astragalus palans* Jones, but is not 2-celled. Jones (Astragalus 203. 1923) made the following remark: "The valves of the pod often curl out like rams' horns, hence arose my name 'arietinus.'" It seems as if Jones at the time thought that his *A. arietinus* was the same as *A. iodanthus*, though he had already before rightly referred it to *A. cibarius* Sheldon.

NEVADA: West Humboldt Mountains and Virginia City, *Watson 269;* Empire City, *Jones, 10, 3837;* Hunter Creek Canon, *Kennedy 1600;* Clover Mountains, *Heller 9082;* Miller Mountain, *Shockley 300;* Reno, *Jones*, in 1897; Virginia City, *Bloomer*, in 1863; Kingston Canyon, *Hitchcock 909.*—CALIFORNIA: Sierra Nevada Mountains, *Lemmon*, in 1875.

2. XYLOPHACOS CIBARIUS (Sheld.) Rydberg. The first mentioning of this species was by Watson in the Botany of the King's Expedition, where it was regarded as a form of the preceding. As a species, *Astragalus cibarius*, it was described by Sheldon who gave a specimen collected by Jones in the Utah Valley as the type. A year later Jones described it under the name *A. arietinus*, his own specimens no. *55540* from Fairview being the type.

UTAH: Spanish Fork, and Utah Valley, *Fremont; Beckwith; Siler; Jones*, in 1880; Great Salt Lake, *Stransbury;* Antilope Island, *Watson 270;* Utah Valley, *Jones 1679;* Logan, *Mulford 23, 48;* Wellsville, *37;* Salt Lake City, *Rydberg 6633; Leonard*, in 1883 and 1884; *Stokes*, in 1901; Oxford, *Leonard 10;* Logan, *C. P. Smith 2322; Mrs. Clemens*, in 1908; *Renselear*, in 1889; *W. W. Jones 165; Garrett*, in 1903; *1734.*—COLORADO: Paonia, Delta County, *Osterhout 4522.*—WYOMING: Evanston, *A. Nelson 2968.*—MONTANA: Bozeman, *Blankinship*, in 1900; San Coulee, *R. S. Williams 745;* Galatin County, *Vogel* in 1901.—IDAHO: Pocatello, *Mrs. Soth 43.*

3. XYLOPHACOS CUSPIDOCARPUS (Sheld.) Rydberg. *Astragalus cuspidocarpus* was described from specimens collected by R. S. Williams at Grafton, Montana. It is closely related to the former and mainly distinguished by the shorter more abruptly acute pod and smaller flowers. A specimen, *Leiberg 171*, was distributed under this name, but it belongs to a species of *Cystium*. Led astray by this specimen, Jones referred *A. cuspidocarpus* first to *A. lentiginosus* Dougl. and later to *A. diphysus* Gray (Astragalus 125. 1923), but in the same publication, p. 213, he made it a variety of *A. Missouriensis*, confusing it with *A. Shortianus minor* A. Gray.

MONTANA: Bozeman, *Chestnut & Jones 203;* Blackfoot River, *Canby 75;* Anaconda, *Blankinship 675.*—IDAHO: Picabo, Blaine County, *Macbride & Payson 2922.*—WYOMING: Mammoth Hot Springs, *Burghlehaus*, in 1893; Yellowstone Park, *Mearns 645, 805.*

4. XYLOPHACOS PUNICEUS (Osterhout) Rydberg. The type of this was collected at Trinidad, Colorado. Jones (Astragalus, in the index) referred it to *Astragalus missouriensis*, but evidently had not seen any specimens. *X. punicens* is not closely related

to any of the other species, is characterized by its tall stems, short, spreading pubescence, which extends even to the fruit. It is placed in the present group on account of its rather thin, arcuate, mottled pod, and rather sparse and spreading, not silvery canescent pubescence. Perhaps it should have constituted a group by itself.

COLORADO: Trinidad, *Osterhout 1737;* near Fishers Peak, Trinidad, *Miss Beckwith 101.*—OKLAHOMA: Kenton, Cimarron County, *G. W. Stevens 468.*

II. CYANEI

Pod tapering at the base, narrowly lanceolate-lunate, decidedly arcuate.
- Leaves linear, obtuse; racemes elongate; calyx black-hairy. — 5. *X. Casei*
- Leaves oval or ovate to elliptic or lanceolate, if narrow, acute; racemes mostly short.
  - Pod mottled, 2–3 cm. long; calyx more or less black-hairy, the teeth less than half as long as the tube; leaflets oval, acute. — 6. *X. Zionis*
  - Pod not mottled, 3–4 cm. long.
    - Calyx-teeth less than half as long as the tube; leaflets obovate or oval, obtuse or acutish; bracts 2–3 mm. long.
      - Leaflets oval, or elliptic, or narrowly obovate.
        - Calyx white-hairy; pod forming nearly half a circle. — 7. *X. amphioxys*
        - Calyx black-hairy, pod forming one-fourth to one-third of a circle. — 8. *X. melanocalyx*
      - Leaflets broadly obovate. — 18. *X. Tidestromii*
    - Calyx more or less black-hairy, the teeth more than half as long as the tube; leaflets lanceolate, very acute; pod about 8 mm. wide, slightly arcuate; bracts 5–8 mm. long. — 9. *X. aragalloides*

Pod rounded, obtuse, or merely acute at the base, obliquely lanceolate or ovate, less arcuate.
- Corolla white or ochroleucous; calyx with mixed black hairs; leaflets mostly oblong or elliptic. — 10. *X. Webberi*
- Corolla usually purplish; calyx mostly white-hairy.
  - Leaflets elliptic to obovate; pod strictly strigose.

Calyx loosely pubescent.
Pod pubescent; leaves pubescent on both sides.
Pod 3–4 cm. long, arcuate, sulcate on the lower suture; corolla more than 2 cm. long. 11. *X. Shortianus*
Pod 2–2.5 cm. long, slightly arcuate, not sulcate; corolla less than 2 cm. long. 12. *X. pephragmenus*
Pod glabrous; leaves often glabrate above at least in age.
Calyx-lobes about half as long as the tube. 13. *X. iodopetalus*
Calyx-lobes less than one-fourth as long as the tube. 14. *X. remulcus*
Calyx with strictly appressed hairs.
Pod lance-ovoid, 2 cm. long or more.
Leaflets elliptic or elliptic-obovate.
Calyx black-hairy, peduncles 3 dm. long; plant green. 15. *X. Chloridae*
Calyx white-hairy; peduncles 1–2 dm. long.
Calyx-teeth about one-third as long as the tube. 16. *X. cyaneus*
Calyx-teeth less than one-fourth as long as the tube. 17. *X. brachylobus*
Leaflets broadly obovate..... 18. *X. Tidestromii*
Pod broadly ovoid 1.5 cm long or less.
Leaflets 9–13, obovate, about 1 cm. long; pod broader than high. 19. *X. castaneaeformis*
Leaflets 15–25, oval or elliptic, 5–7 mm. long; pod higher than broad. 20. *X. tephrodes*
Leaflets lance-oblong, acute; pod hirsutulous. 21. *X. argophyllus*

5. **Xylophacos Casei** (A. Gray) Rydberg. (*Astragalus Casei* A. Gray. Bot. Calif. 1: 154. 1876.)

This species was described from specimens collected near Pyramid Lake, Nevada, but its range extends southward to the

Death Valley, California. Dr. Gray associated it correctly with *Astragalus iodanthus* and *A. Webberi*, notwithstanding the narrow leaflets. The pod resembles that of the former but is thicker, less mottled, and pubescent. The pubescence of the leaves is that of *X. Webberi*, but the pod is more ob-compressed, narrower, and more tapering at the base. The species is perhaps more closely related to *X. amphioxys*, differing in the narrower leaflets, elongate inflorescence, and black-hairy calyx. Jones (Astragalus 147. 1923) placed it with *Astragalus Grayi* and *A. pectinatus*, with which it has no close relationship.

NEVADA: Pyramid Lake, *Lemmon & Case;* Candelaria, *Jones 354;* Hawthorn *Jones 3834, Lemmon 67;* Gold Mountain, *Purpus 5984.*—CALIFORNIA: Owens Valley, *Jones*, in 1897; Panamint Mountains, *Coville & Funston 747;* Inyo County, *Hall & Chandler 7154;* San Bernadino Mountains, *Jones 6235.*—WASHINGTON: Walla-Walla, *Brandegee 720.*

6. XYLOPHACOS ZIONIS (M. E. Jones) Rydberg. This species is evidently related to *X. amphioxys* and *X. aragalloides*, though the pod is less tapering at the base, shorter, and distinctly mottled.

UTAH: Springdale, *Jones 5239, 5249 g* and *h.*

7. XYLOPHACOS AMPHIOXYS (A. Gray) Rydberg. *Astragalus amphioxys* A. Gray was based on *A. Shortianus* var.? *minor* A. Gray, Proc. Am. Acad. **6:** 211, "*magna pro parte*" and *A. cyaneus* S. Wats. Am. Nat. **9:** 270. The latter included *Parry 46* and *49*. Dr. Gray also cited the following collectors: "Thurber, Parry, Palmer, &c." Turning to the publication of *A. Shortianus minor* we find that it was based on "*A. cyaneus* A. Gray Pl. Fendl. p. 34 (*magna pro parte*)." *A. cyaneus* A. Gray was wholly based on *Fendler 148*. It seems therefore that, if literally interpreted, *A. amphioxys* would be a mere substitute for *A. cyaneus* A. Gray. Evidently Dr. Gray did not mean *A. cyaneus* (*magna pro parte*) in Plantae Fendlerianae, but *A. cyaneus* (*magna pro parte*) as he had extended his conception in the mean time, which included *A. cyaneus* of the Botany of the Mexican Boundary Survey, i. e. *Thurber 295* from Dona Ana, New Mexico, and *Mexican Boundary Survey 255* from El Paso. The latter number was omitted in the published volume, but is inserted in lead-pencil in Dr. Torrey's private copy. Both of

these I regard as typical *A. amphioxys*. Thurber's specimens (in flower only) are the first mentioned under that species, and should be regarded as the type, if *A. amphioxys* is to be limited to the first synonym mentioned. *Fendler 148* can not be so regarded as it does not agree with Dr. Gray's description.

The second synonym under *A. amphioxys* may be considered by some botanists, as *Parry 46* and *49* are mentioned first, merely to connect with the reference in the American Naturalist. If so there will arise another serious trouble, for *Parry 46* and *49* are not alike. The former is cited first and it agrees best with the description having "foliis saepius oblongis acutis." I regard this number as belonging to *X. aragalloides*, while *no. 49* is the same as *Thurber 295* and *Mexican Boundary Survey 255*, or as I take it, *X. amphioxys*. In the Gray Herbarium *no. 49* has been changed by Dr. Gray to *A. amphioxys* Gray n. sp. while *no. 46* remained unchanged as *A. cyaneus*.

It is therefore best to regard *Thurber 295* as the type. In this case the specimens cited by Gray, viz. "Thurber, Parry, Palmer &c." belong to *X. amphioxys* except *Parry 46*. Sheldon has determined *Parry 49* in the Columbia Herbarium as *Astragalus crescenticarpus* but it was not included in the original description and does not seem to fit it. The same number in Gray Herbarium he determined as *A. Shortianus*, and *no. 46* as *A. amphioxys*.

TEXAS: El Paso, *Mexican Boundary Survey 255: Vasey*, in 1881.—NEW MEXICO: Rio Grande, *Thurber 295*, Frontera, *Mexican Boundary Survey (Parry) 255;* Albuquerque, *Winnee Harward*, in 1900; *Kammerer 37*.—ARIZONA: *Palmer 105, 115*, in 1876; Grand Cañon, *Lemmon 4167;* Franconia, *Jones*, in 1903. —UTAH: St. George, *Parry 49;* Washington, *Jones*, in 1880.—NEVADA: Meadow Valley Wash, *Jones*, in 1914.—CHIHUAHUA: Paso del Norte, *Pringle 201*.

8. **Xylophacos melanocalyx** Rydberg, sp. nov. (*Astragalus amphioxys* M. E. Jones, Astragalus 214, in part. 1923. *Astragalus amphioxys* × *Layneae* M. E. Jones, Astragalus 215. 1923.)

Perennial, with a cespitose calyx; stems many, 2–7 cm. long, decumbent or ascending, white-strigose, densely covered with leaves; leaves 5–10 cm. long, ascending or spreading; stipules deltoid, 5–8 mm. long, white-strigose; leaflets 11–19, oval or obovate, 5–10 mm. long, 2–5 mm. wide, white silky-strigose on

both sides, obtuse at each end; peduncles 7–15 cm. long, erect, white-strigose; bracts lanceolate, 2–3 mm. long, membranaceous; flowers subsessile; calyx black-hairy, the tube 6–7 mm. long, 3–3.5 mm. broad, the lobes deltoid-subulate, 2 mm. long; corolla bluish-purple, 15–18 mm. long; banner obovate, moderately arched; wings shorter, the blade oblong, acutish, with a large reflexed basal auricle; keel-petals nearly as long as the keel, the blades lunate, rounded at the apex; pod crescent-shaped, about 3 cm. long, 1 cm. broad and 5–7 mm. deep, cross-wrinkled, white-strigose with somewhat kinked hairs.

Type collected at Copper Mine [west of St. George], Utah, April 4, 1894, *Jones 5009* (Pomona College herbarium).

The type constituted a part of Jones' *Astragalus amphioxys* × *Layneae*. The plant is evidently related to *X. amphioxys* and might have been made a variety thereof, differing mainly in the black-hairy calyx, darker colored corolla and comparatively broader and less curved pod. I think that Jones is mistaken, however, in regarding it a hybrid with *Astragalus Layneae* A. Gray, i.e. *Hamosa Layneae* (A. Gray), the plant having no feature characteristic to that species and not found in *X. amphioxys*. In fact three numbers of Jones' own collecting and named by him simply as *A. amphioxys* belong to *X. melanocalyx*. One of these was collected at the same locality and the same date as the type of the so-called hybrid. To me it seems to be a part of the same collection. *Jones 5009* from the Copper Mine was assigned as the type as it is the only one having an old fruit.

UTAH: Copper Mine, April 4, 1894, *Jones 5009* (named *H. amphioxys* × *Layneae*); Beaver Dam Mountains, *Tidestrom 9344*.—ARIZONA: Beaverdam, April 5, 1894, *Jones 5009*. Chimehuvis, April 21 and 23, 1903, *Jones* [one sheet (Pomona College number 25956) of the former was named *A. amphioxys* the other (no. 45600) was named *A. amphioxys* × *Layneae*]; Vicinity of Kayenta, *John Welterill*, in 1922.

9. XYLOPHACOS ARAGALLOIDES Rydberg. Jones gives this as a synonym of *Astragalus amphioxys*, which is true only in part as to *Parry 46*. See notes under the preceding species. It differs from the same in the characters given in the key. Besides the hairs of *X. aragalloides* are filiform cylindric, not tapering at both ends, or as Jones calls them "pick-shaped" in describing *A. amphioxys*.

UTAH: St. George, *Jones 1633*; *Palmer 101*, in 1877; *Parry 46*.

10. **Xylophacos Webberi** (A. Gray) Rydberg. (*Astragalus Webberi* A. Gray, Bot. Calif. **1**: 154. 1876.)

This species resembles somewhat *X. cibarius* and *X. cuspidocarpus* in general appearance and in the flowers, but is more hairy, and the pod resembles more that of *X. Shortianus*.

CALIFORNIA: Plumas County, *Mrs. Ames*, in 1875; *Lemmon 74; Mrs. Clemens* in 1820; *Mrs. Austin*.

11. XYLOPHACOS SHORTIANUS (Nutt.) Rydberg. This is characterized by the broad, silvery leaflets, the large corollas, the silky-villous rather than strigose calyx, and the large pod, rounded at the base, strongly arcuate, more or less sulcate on the lower suture and obcompressed except at the tip.

WYOMING: Telephone Canon, *A. Nelson 54;* Albany County, *A. Nelson 2898, 7021;* Laramie Hills, *E. Nelson 54, 227;* Laramie Plains, *Osterhout;* Uintah County, *Stevenson 8*.—COLORADO: Boulder, *Patterson;* Clear Creek, *Hall & Harbour;* Colorado Springs, *Sturgis*, in 1915; *Jones 80;* without locality, *Hulse*, in 1870; *Fremont;* Wet Mount Valley, *Brandegee*, in 1873; Morrison, *Clokey 3108;* Boulder County, *Tweedy 5639, 5155;* Fort Collins and vicinity, *Cowen*, in 1896; *C. F. Baker*, in 1896; Ute Pass, *Biltmore Herbarium 1492;* Clear Creek, *Coulter;* Denver, *Rydberg & Vreeland 5976;* Grand Junction, *Crandall*, in 1898; Monument, *Johnston & Hedgecock 667;* Howe's Gulch, *Crandall, 288*; Colorado Springs, *Eggleston 11164;* La Porte, *Crandall 776,* Golden, *Letterman*, in 1885; Bronson, *Eggleston 20170*.—NEW MEXICO: Emory Gap, Union County, *Eggleston 20159*.

12. **Xylophacos pephragmenus** (M. E. Jones) Rydberg. (*Astragalus pephragmenus* M. E. Jones, Zoe **4**: 267. 1893.)

The specimen in the National Herbarium, marked in Jones' own handwriting, "Type Specimen!" represents a rather stout branch with unusually large stipules, but otherwise I can not see that it is specifically distinct from the common form represented by *MacDougal 27* and *199*. It is not closely related to *A. argophyllus*, of which Jones made it a variety in his revision of Astragalus (p. 208).

Two years later Jones described *Astragalus intermedius* (Proc. Calif. Acad. II. **5**: 656. 1895), based on specimens in flower in the National Herbarium, collected by Palmer in Arizona. On

the same sheet there is mounted an envelope containing old fruit of some species of true *Astragalus* (perhaps *A. mogollonicus* or *A. marcidus*); from these pods the description of the fruit was drawn. There is no evidence however, that these pods belonged to the same plant. Three years later Jones changed the name to *A. Phoenicis* (Contr. W. Bot. **8**: 12. 1898) as the name *A. intermedius* was preoccupied. Jones has distributed two sets of specimens determined as *A. Phoenicis*. One set from Skull Valley, collected April 28, 1903, matches the type of *A. intermedius*, but has fruit like those of *MacDougal 27* and *199*. In his "Astragalus," Jones transferred these to *A. remulcus*, the original of which had glabrous pods. The other set from Chloride, Arizona, represents a much larger plant, almost green and with black-hairy calyx. This evidently afterwards became the type of *A. remulcus Chloridae* (Astragalus 210. 1923).

The type of *Xylophacos lenophyllus* Rydb. was mistaken for *A. remulcus* M. E. Jones and Jones included it in his description of that species in his revision of *Astragalus*. It differs, however, in the pod, which is pubescent, and in the leaflets which are pubescent on both sides. It is a smaller plant than *X. Shortianus*, has smaller and not so coriaceous pods, thin-walled and not sulcate on the lower suture, and shorter calyx-lobes. On account of the latter character it has been regarded as the same as *A. amphioxys brachylobus* A. Gray, but the latter is smaller, with a distinctly appressed pubescence, even as to the calyx.

I therefore think that *A. intermedius*, *A. Phoenicis* and *Xylophacos lenophyllus* should be regarded as synonyms of *A. pephragmenus*.

ARIZONA: Vicinity of Flagstaff, *MacDougal 27; 199*, in 1898, also in 1891; without locality, *Palmer 102*, of 1876, not of 1877. San Francisco Mountains, *Tidestrom 961;* Skull Valley, *Jones;* Flagstaff, *Rose 12107*.—NEW MEXICO: Probably near the Copper Mines [Santa Rita], *Mexican Boundary Survey 260* (named *A. glareosus?*).—UTAH: Pindo Cañon.

13. **Xylophacos iodopetalus** (Greene) Rydberg, n. sp. (*Xylophacos stipularis* Rydb. Fl. Rocky Mts. 504, 1063, mainly. 1917. Not *Astragalus arietinus stipularis* M. E. Jones, 1895. *Astragalus iodopetalus* Greene, Ms. in herb.)

Perennial with a cespitose caudex; stems 1–2 dm. high, sparingly pilose or glabrate; leaves 1–2 dm. long; stipules large,

scarious, deltoid, 6–8 mm. long; leaflets 21–27, obovate to elliptic, 5–15 mm. long, 4–8 mm. wide, glabrate above, silky-pilose beneath; peduncles 5–10 cm. long; racemes short and dense; bracts lanceolate, 4–7 mm. long; calyx silky-pilose, the tube 8–10 mm. long, the teeth lance-subulate, 3 mm. long; corolla purple, fully 2 cm. long; banner obovate, slightly retuse; wings shorter, the blades oblong, with a large basal auricle; keel-petals still shorter, the blades broadly obliquely obovate, arched and rounded at the apex; pod lanceolate in outline, arcuate, acuminate at the apex, obtuse at the base, cross-reticulate, 2.5–3 cm. long, glabrous.

Type collected at Arboles, Colorado, June 1899, *Baker 415* (herb. N. Y. Bot. Gard.).

This resembles in some respects *X. Shortianus* and has the same loose pubescence on the calyx, but the stem is better developed, the pubescence of the leaves is looser and sparser, and the pod is glabrous. It differs from *X. remulcus* in the longer calyx-teeth, which are about half as long as the tube.

COLORADO: Sapinero, *Baker 184;* Arboles, *Baker 415;* Ceballo, *N. L. T. Nelson 23;* Montrose, *Payson 87.*—NEW MEXICO: Kingston, *Metcalfe 1056.*

14. **Xylophacos remulcus** (M. E. Jones) Rydberg. (*Astragalus remulcus* M. E. Jones, Proc. Calif. Acad. II. **5**: 658. 1895.)

This is closely related to the preceding. It was described from *Rusby 576.* In this the pod is young, evidently glabrous from the beginning, shorter than in the two preceding, with a very prominent upper suture, and the leaflets are glabrous above, silky-villous rather than strigose beneath. Jones' description in his "Astragalus" fits better *X. pephragmenus*, which was also included. Sheldon included it in *A. amphioxys brachylobus* A. Gray. This may explain why Jones cited the latter as a synonym. The original var. *brachylobus* is, however, evidently not the same. In general habit *X. remulcus* resembles closely *A. mokiacensis* A. Gray, but the calyx is longer, the racemes shorter, and the structure of the pod different.

ARIZONA: Bangharte Ranch, *Rusby 576;* Fort Verde, *Mearns 345;* Santa Catalina Mountains, *Griffiths 2287;* Atargue de Gracia, *Wooton*, in 1906; Jerome Junction, *Marsh*, in 1905.

15. **Xylophacos Chloridae** (M. E. Jones) Rydberg. (*Astragalus remulcus Chloridae* M. E. Jones, Astragalus 210, 1923.)

Related to the preceeding but a larger and greener plant, with peduncles often 3 dm. long and black-hairy calyx. The type came from Chlorida, Arizona. Another specimen from Arizona, viz. *Lemmon 3354* may belong here.

16. **Xylophacos cyaneus** (A. Gray) Rydberg. *Astragalus cyaneus* A. Gray, Mem. Am. Acad. II. **4**: 34. 1849.)

This was described from flowering specimens, together with some old loose pods. The former resembles a small plant of *X. missouriensis*, but the pods resemble those of *X. Shortianus* though smaller. Gray therefore reduced the species later to *A. Shortianus minor*, though he confused with it specimens of *X. amphioxys*. Wooton & Standley regarded it as a synonym of *A. Shortianus*. Jones for some time regarded it as a synonym of *A. missouriensis* and lately (Astragalus 213. 1923) he made it a synonym of *A. missouriensis cuspidocarpus*, wholly misunderstanding *A. cuspidocarpus* Sheldon, which is related neither to *A. missouriensis* nor to *A. cyaneus* but to *A. cibarius*. I myself have added to the confusion by misunderstanding both *A. cyaneus* and *A. unitensis*. What I have described in my Flora of the Rocky Mountains under the name *Xylophacos unitensis* Rydb. is mostly *X. cyaneus*.

NEW MEXICO: Santa Fe, *Fendler 148; Heller 3519; Bro. Bertaud 114;* Las Vegas, *Bro. Anect 103;* Gila Forest, *Eggleston 17001, 16955;* Shiprock, *Standley 7181;* Kingman, *Vasey*, in 1881.—COLORADO: Mancos, *Baker, Earle & Tracy 56;* Wootton, *Rusby*, in 1909; Pueblo, *Rydberg & Vreeland 5975;* Grand Junction, *Crandall;* Cripple Creek, *Tweedy 255;* Albuquerque, *Mary Cooper*, in 1909; Delta, *Tidestrom 2178.*—OKLAHOMA: Woods County, *G. W. Stevens 220;* Harper County, *303, 527, 263;* Beaver County, *337, 359;* Cimarron County, *472;* Texas County, *388.*—TEXAS: Grady, Fisher County, *Shepherd*, in 1901. —ARIZONA: *Rothrock 1112.*

17. **Xylophacos brachylobus** (A. Gray) Rydberg. (*Astragalus Shortianus brachylobus* A. Gray, Proc. Am. Acad. **13**: 367. 1878.)

This species was first collected by Edward Palmer (*no. 115* in 1876, and *no. 102*, 1877) in Northern Arizona. On the latter, Dr. Gray based the variety. Jones has applied this name as a synonym of *A. remulcus*, but evidently he was in error, though

A. remulcus and *X. lenophyllus* both have short calyx-teeth and therefore would agree with Gray's short description. *Palmer 102*, the only specimens Dr. Gray had before him at the time, evidently must be regarded as the type.

ARIZONA: without locality, *Palmer 115*, in 1876; *Palmer 102*, in 1877; also *316;* Holbrook, *Miss Zuck*, in 1896; Clifton, *Rusby;* Pinal Mountains, *Jones*, in 1890; El Tovar, Grand Cañon, *Setchell*, in 1907; Peach Spring, *Lemmon*, in 1884; Carriosa Mountains, *Standley 7477;* Winslow, *Ward*, in 1901; Petrified Forest, *Ward* in 1901; Holbrook, *Zuck*, in 1896.—NEW MEXICO: Albuquerque, *Herrick*, in 1894; Mangus Springs, *Rusby 90½;* Santa Fe, *Earle 82; Fendler 149, Edwards;* without locality, *Miss Harward*, in 1900; Silver City, *Eggleston 19953, 19955.*—COLORADO: Los Pinos, *Baker 426.*—UTAH: Kanab, *Mrs. Thompson;* Belknap, *Stokes* in 1900.—NEVADA: St. Thomas, *Tidestrom 8673.*

18. **Xylophacos Tidestromii** Rydberg, sp. nov. Perennial, with a deep woody root and short cespitose caudex; subacaulescent; stems 1–5 cm. long, white-woolly; leaves 5–8 cm. long, spreading, stipules broadly deltoid about 5 mm. long; leaflets 11–15, broadly obovate, 6–12 mm. long and nearly as broad, densely white, silky-villous on both sides, cuneate at the base, rounded at the apex; peduncles 5–7 cm. long; racemes 2–4 cm. long; bracts lanceolate, 2–4 mm. long; calyx with mixed white and black hairs, the tube 6–8 mm. long, the teeth subulate, 2 mm. long; corolla unknown, except the keel-petals which are 12 mm. long, the blade broadly lunate, with a large auricle, purple-tipped, and shorter than the claw; pod tapering at each end, strongly arched above the middle, strigose-canescent, cross-reticulate, about 4 cm. long, 4 mm. high and nearly 1 cm. broad.

Type collected in Charleston Mountains, Nevada, May 27, 1919, *Ivar Tidestrom 9661* (U. S. Nat. Herb. *1117336.*)

This species is related to *X. amphioxys* but differs in the broader leaflets, the broader and less attenuate pod. To it is also referred the following specimen, *Goodding 2283* from Las Vegas, Nevada, which has more silky pubescence and a shorter less tapering pod, 3 cm. long.

19. **Xylophacos castaneaeformis** (S. Wats.) Rydberg. (*Astragalus castaneaeformis* S. Wats. Proc. Am. Acad. **20**: 361. 1885.)

This species differs from the rest of the group in the short obliquely ovoid pod and rather few leaflets.

ARIZONA: Flagstaff, *MacDougal 36; 66;* Bill Williams Fork, *Bigelow*, on Whipple's Expedition, 1854; Williams, *Lemmon 3262;* Grand Cañon, *Toumey.*

20. **Xylophacos tephrodes** (A Gray) Rydberg. (*Astragalus tephrodes* A. Gray, Pl. Wright, **2**: 45. 1853.)

This species is imperfectly known from a single specimen collected in the Organ Mountains, New Mexico by C. Wright.

21. XYLOPHACOS ARGOPHYLLUS (Nutt.) Rydberg. This is probably most closely related to *X. cyaneus*, but differs in the narrower, acute leaflets, the longer calyx-lobes and stipules, and the longer and coarser pubescence of the pod. It approaches *X. glareosus* and has been mistaken for it, but the pod is not villous, though the hairs are long; they are straight or nearly so.

MONTANA: Dillon, *Shear 3438.*—WYOMING: *Nuttall; Porter*, in 1873.—NEVADA: Ruby Valley, *Watson 281*, in part; Palisade, *Jones*, in 1882; Lewiston, *Zundle*, in 1900.—UTAH: Logan, *Garrett, F. 2297*, Weber Cañon, *Armstrong*, in 1912; Wasatch County, *Carleton & Garrett 6699;* Parley's Cañon, *Garrett 2132;* Juab, *Goodding 1290;* Silver Reef, *Jones 5163 h;* Monticello, *Rydberg & Garrett 9153;* Juab, *Jones 6336 B;* Logan Cañon, *C. P. Smith 2162;* Salina Cañon, *Jones 5428;* without locality, *Parry 25;* Parley's Park, *Watson 281;* Park City, *Jones;* Deep Creek, *Jones.*

Astragalus argophyllus cnicensis M. E. Jones is nearly typical *X. argophyllus. A. argophyllus Martini* M. E. Jones is a depauperate form with very short peduncles and rather broad leaflets. It is represented by the following three specimens.

IDAHO: Blaine County, *MacBride & Payson;* Soda Springs, *Martin;* Arco, *Palmer 164.*

Germination of the spores of Riccardia pinguis and of Pellia Fabbroniana

A. M. Showalter

(WITH TWO TEXT FIGURES AND PLATE 5)

The following study with the spores of *Riccardia pinguis* (L.) S. F. Gray (= *Aneura pinguis* Dumort.) was undertaken to determine the origin of the apical cell. The spores were sown on thin agar plates (about 1.3% in tap water) in shallow petri dishes, and the covers were fastened in place with strips of gummed paper. The petri dish could then be placed on the stage of the microscope and the sporelings examined without removing the cover. By the use of indices on the cover it was easy to find again a given sporeling and thus to make camera lucida sketches showing successive stages in its development.

This of course permitted the use only of the low power objective (Leitz no. 2) and the image lacked clearness. Intracellular details could not be determined and it is probable that cell divisions were apparent only after the formation of a cell wall.

The spores were sown March 23, 1923 and the cultures were kept in the Bryophyte greenhouse of the National Botanical Garden at Brussels. The temperature and light intensity were both rather low and in most cases the first division of the spores was apparent only about a month after the sowing.

The changes in the spore preceding the first division have been described by Miss Clapp (1912) and need not be repeated here. As observed in other cultures and as reported by Miss Clapp the first division of the spore is very unequal. The smaller cell then grows and divides, again more or less unequally, in a plane which intersects the previous division wall FIG. 1, a_1, b_2, c_1, d_1), (Miss Clapp's *fig.* 59). The smaller of these two cells grows more rapidly than its sister and divides, again unequally, in a plane which intersects the previous wall and marks out a well defined apical cell (FIG. 1, a_2, b_4, c_2, d_2). This apical cell continues to grow and give off, alternately right and left, segments each of which is larger than the remaining apical cell, as is characteristic of the apical cell in the older plant (FIG. 1, a, b, c, d).

All these divisions beginning with the first division in the spore are unequal and in each case the smaller cell grows more rapidly and divides before its sister. The segments are given off alternately right and left except the first which is posterior to the direction of growth. This suggests that the spore itself in effect functions as an apical cell, but I have no evidence to show that its polarity is fixed, as seems to be the case in *Pellia Fabbroniana* described below.

The segments given off by the apical cell may, very early, undergo further division (FIG. 1, d_3, d_5) but in this experiment

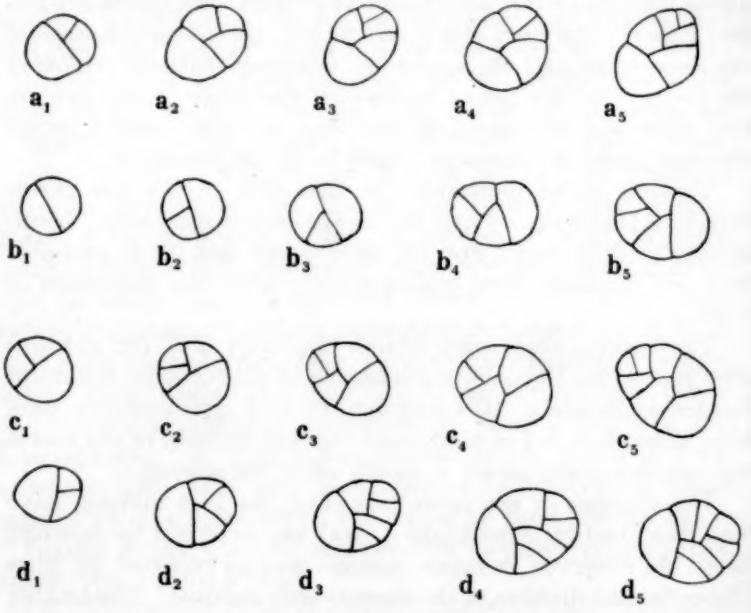

FIG. 1. Four sporelings of *Riccardia pinguis* sketched in successive stages of development; a_1, b_1, c_1, d_1 sketched May 5, 1923; b_2, c_2 sketched again May 7; a_2, b_3, c_3, d_2 sketched again May 10; a_3, d_3 May 12; a_4, b_4, c_4, d_4 May 17; and a_5, b_5, c_5, d_5, May 19.

no case was observed in which the first segment (the posterior cell formed by the first division) had divided. An experiment described below shows however that this cell may divide.

The spores of this species may also be germinated on the slide and some of the protoplasmic changes accompanying nuclear and cell division may be observed *in vivo*. A clean slide

is sterilized in the flame of a bunsen burner or alcohol lamp and when sufficiently cooled a few drops of warm agar solution (about 1.5% in tap water) are poured on the slide. As soon as the solution begins to congeal at its edge a few freshly shed spores are dropped on the liquid surface and a clean sterilized cover slip is added. The preparation is placed in a moist chamber (petri

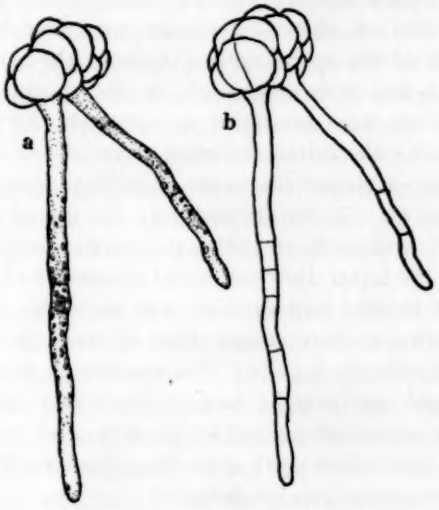

FIG. 2. Sporeling of *R. pinguis* (a) sketched May 25, and (b) again June 9. Further explanation in text.

dishes were used) before a north window. Spores in such culture-preparations underwent the first division in from ten to fifteen days. The daily variations in the temperature of the laboratory caused the agar to dry out but some of the sporelings developed to the three-celled stage.

At the time these culture-preparations were made there was on my table a watch glass with spores which had germinated in tap water and had developed to the two-celled stage—the stage at which sporelings in water culture usually die. A few culture-preparations similar to those just described were made, using these two-celled sporelings instead of freshly shed spores. In one of these culture-preparations the sporelings developed to about a dozen cells each and produced rhizoids of considerable length (FIG. 2).

The rhizoids were formed as abrupt outgrowths from cells near the posterior end of the sporeling but in no case did I find a rhizoid arising from the end cell—*i. e.* the first segment given off by the germinating spore. This cell is easily distinguished by its brownish color due to the presence of a large part of the exine of the spore which adheres to and covers all its free surface. (Miss Clapp's *figs. 61, 62*).

Disintegration of these sporelings was first noticeable in the young cells of the apical end. At about the same time that disorganization was first noticeable in the apical end, nuclear and cell divisions were observed to occur in the rhizoids and in the oldest cell—the initial segment given off by the germinating spore. FIG. 2 shows the same sporeling sketched May 25 and again June 9. At the former date the initial segment was still undivided and each of the two rhizoids had divided into two cells. At the latter date the initial segment had divided once and the larger rhizoid had divided into six cells. Other sporelings in the same culture-preparation showed rhizoids divided into varying numbers of cells. The maximum number of cells into which any one rhizoid had divided was seven. These divisions were not accompanied by growth, and in none of the rhizoids, sketched before and after the divisions had occurred, could any increase in size be detected.

Goebel (1906) describes multicellular rhizoids in *Gottschea*, which, I think, is the only other record of such rhizoids in the Hepaticae. The divisions here reported in the rhizoids of *Riccardia* have occurred, it is true, under highly special physico-chemical conditions, but these conditions probably do not exceed the range of conditions in nature.

PELLIA FABBRONIANA

It has long been known that the spores of *Pellia* germinate before being shed from the sporogone (Hofmeister '51, Müller '66, Leitgeb '77). Upon examining sporogones of *P. epiphylla* collected January 18, 1924, in the Forêt de Soigne near Brussels I was surprised to find the "spores" already consisting of four to eight cells each, although the sporogones were still quite small. It occurred to me to examine *Pellia Fabbroniana* Raddi, of which there were about two dozen sporogones in one of my greenhouse cultures. Since the number of sporogones available

was so small they were used only sparingly in order to get the maximum of information from the material available.

Two of these sporogones were examined the same day (January 18). One of them showed the large four-lobed spore mother cells in some of which the cell division was not yet complete (FIG. 3). The lobes of the spore mother cell (and the spores formed from them) are long ovoid with the long axis about twice as great as the median transverse diameter (FIG. 3, 4, 5). In many of these spore mother cells the spindle of the last division was still distinguishable and appeared to be composed of granular strands. The protoplasm in the immediate vicinity of the spindle was free of chloroplasts but contained numerous small refractive bodies (whether globules of liquid or more solid bodies was not determined). Chloroplasts were so numerous in the rest of the space within the cell as to obscure all other structures from view.

When these spore mother cells were placed in water one or more of the lobes of each cell burst at its distal end and allowed the protoplasm to flow out. In some cases the fissure in the cell wall was small and the outflow of protoplasm was very slow. In such cases the granules in the strands of the spindle could be seen to migrate toward the lobe from which the protoplasm was exuding. As the movement was accentuated, single chloroplasts were seen to pass along one of the strands of the spindle and to migrate over to the discharging lobe, the spindle remaining in its original form and position until a considerable quantity of the protoplasm had been exuded. This suggests that these cells might be favorable objects for microdissection studies of the structure of the achromatic spindle.

The other sporogone examined at the same time showed about half of the spores once divided, about one-fourth with an incomplete cell plate, and about one-fourth in which no indication of the division was apparent. These were mounted in water and when examined under the microscope the spores had separated from their tetrad sibs and no exospore wall was visible on them. (It was later observed that "spores" up to the time of the second division are held together in tetrads by the exospore but when placed in water this exospore ruptures at the free end of each lobe and the "spores" pop out leaving behind the four-lobed gelatinous cell wall of the spore mother cell with its echinate surface.)

The first division wall in the spore is almost longitudinal (FIGS. 4, 5). (See also Leitgeb's *fig. 10, pl. 3.*) During the later stages of this division and in the newly formed daughter cells the chloroplasts form two opaque masses (enclosing the nuclei) on opposite sides of the median part of the cell plate. In the end portions of the cells are many small refractive colorless bodies which exhibit a vigorous Brownian movement and to which is imparted a dark color when the "spore" is thrown into a fixing solution containing osmic acid.

A few sporogones from the same culture were fixed the same day, imbedded in paraffin and sectioned in the usual way. These showed, in different sporogones, spore mother cells in which the nucleus had not yet divided, one-celled spores, and two-celled "spores." Some of the one-celled spores show various stages of the first nuclear division but none were found to show satisfactorily the formation of the cell plate. The achromatic spindle of this mitosis is long and slender with its long axis coincident with the long axis of the spore. It would be interesting to know the changes which intervene between this nuclear division and the formation of the cell plate which divides the spore into two cells.

The second division occurs simultaneously in the two sister cells and divides each of them transversely (FIG. 6). Stained sections show that the achromatic spindle is longitudinal and is followed by a cell plate transecting its longitudinal axis as is usually the case in plant cells. Three of the cells resulting from the second division are about equal in size and are filled with chloroplasts, but the fourth is smaller and contains only a few chloroplasts (FIGS. 6–9). This latter cell is closely analagous in form and function to the "basal cell" in the "spore" of *Pellia epiphylla* described by Hofmeister ('51) and its position with reference to the other "spores" of the tetrad and with reference to the direction of growth shows further the appropriateness of this name.

Soon after the beginning of the four-celled condition of the "spore" the tetrads may be obtained by gently opening the sporogone in water. These tetrads show clearly that the basal cell of each "spore" is in contact with that of each of the other three of the tetrad (FIG. 7). This is evident also in stained sections of sporogones at all stages of development after the

early prophases of the second division of the "spore." The area of the "spore's" surface held in contact with its tetrad sibs is at or near the end, but oblique to the long axis of the "spore". (FIG. 7).

The basal cell undergoes no further division although it enlarges considerably. The third division occurs almost simultaneously in the other three cells (FIG. 10). The stained preparations show in some cases a slight advance of the mitosis in the terminal cell over the mitoses in the two median cells. This division in the two median cells is always transverse, parallel to the plane of the preceding division. The terminal cell divides sometimes parallel to and sometimes at right angles to the plane of the preceding division (FIG. 10). (FIGS. 9 and 10 represent "spores" from the same sporogone examined February 9.)

The "spore" remains subcylindrical in shape and the first three divisions are all visible from one side of the "spore" (FIG. 10). In sporogones whose setae had begun the rapid elongation which normally precedes the discharge of the "spores" the latter consisted of about a dozen cells each. I am unable to say with certainty whether or not all of the six cells formed by the third division had divided, but in some cases, at least five of them had done so. In the cells of the median portion of the "spore" this division is at right angles to all the preceding divisions (FIG. 13) but in the terminal cell the dividing septum intersects only the last previous septum and the free outer surface of the cell (FIGS. 11, 12) as is typical of the divisions of the apical cell in the older plant. When such a "spore" is viewed in the plane of the earlier divisions these walls are distinguishable by their relative optical thickness (FIGS. 11, 12). In these figures the line 1.....1 represents the first division wall, 2.....2 the second, 3.....3 the third, and 4.....4 the fourth in the terminal cell, the fourth division in the cells of the median portion of the "spore" being in the plane at right angles to these and visible only when the "spore" is rotated on its long axis through 90° (FIG. 13).

Beginning in the four-celled condition of the "spore" the exospore adheres to the "spore" and is noticeable on the living "spore" chiefly by the echinate thickenings on the surface. The exospore covers the entire surface of the "spore" except that portion of the basal cell which remains in contact with the

other "spores" (FIGS. 7–10). This exospore expands as the "spore" enlarges and its presence becomes more and more difficult to detect, especially on the surface of the terminal region, as in *Riccardia* (Clapp's *figs. 61, 62*).

When "spores" of the condition represented by FIGS. 11–13 are placed in water culture the basal cell soon gives rise to a rhizoid. FIG. 14 represents such a spore after twenty-five hours in water culture; FIG. 15 represents another spore from the same culture after fifty-four hours in water. The nucleus, chloroplasts and most of the granular cytoplasm of the basal cell pass into the rhizoid.

Unfortunately the paucity of material of this species and the pressure of other duties did not permit me to follow the later stages of germination or to determine whether the cell designated *a* in FIGS. 11 and 12 continues to function as the apical cell or whether another cell may take that rôle. Leitgeb ('77) describes (his *fig. 14, pl. 3*) the apical cell as arising in this portion of the "spore," but Müller ('66) says that rhizoids appear at the two ends of the "spore" and that the apical cell arises in the median portion (his *figs. 55–59, pl. 38*). It seems probable that a high degree of plasticity exists in these cells and that any one of them (excepting the basal cell) may be capable of functioning as an apical cell if the metabolic gradient be favorably altered by external conditions.

If, as seems probable from these observations and from Leitgeb's description of the later stages of germination, the cell designated *a* in FIGS. 11 and 12 continues under normal conditions to function as an apical cell, we can hardly escape the conclusion that the spore itself is in effect an apical cell with its polarity fixed at the time of its formation from the spore mother cell. The examination of a large number of "spores," both fresh and in stained paraffin sections, shows that the plane of the first division has a definite and constant relation to the point of attachment of the spore to its tetrad sibs, and therefore to the plane of the division of the spore mother cell by which the spore is formed (FIGS. 7–10). The succeeding divisions (2....2, 3....3, and 4....4, FIG. 11) follow the order characteristic of the apical cell of the Anacrogynae. There is one point, rather insignificant it seems to me, which may constitute an objection to this hypothesis. The second and third segments

are in some cases given off from the same side of the apical cell (FIG. 12).

It is not possible to say from my observations what part of the apparent polarity of the spore is conditioned by factors external to the protoplasm and what part to internal factors. Here again further study may yield interesting results.

DEPARTMENT OF BOTANY,
UNIVERSITY OF WISCONSIN

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Explanation of plate 5

All figures were drawn with the aid of the camera lucida from living material mounted in water; at a magnification of about 630 diameters, except the last (FIG. 15) which was drawn at about 490 diameters; reduced in reproduction about 2/5.

FIG. 3. Spore mother cell from sporogone grown in greenhouse, examined and drawn Jan. 18, 1924. Achromatic spindle and adjacent parts of cell and the outline of the entire cell copied as accurately as possible. Chloroplasts in terminal part of lobe at the left filled in diagrammatically.

FIG. 4. Spore from sporogone grown in greenhouse, examined and drawn Jan. 18, 1924. The first division is in progress, as nearly an optical section as could be obtained with the camera lucida.

FIG. 5. "Spore" once divided, from same sporogone as that represented in FIG. 4 and similarly drawn.

FIG. 6. Living "spore" from sporogone grown in greenhouse, examined and drawn Jan. 28, 1924.

FIG. 7. Living "spore" still attached to its tetrad sib, from sporogone collected in Forêt de Soigne, examined and drawn Feb. 12, 1924.

FIG. 8. Living "spore" from greenhouse culture, examined and drawn Feb. 2, 1924.

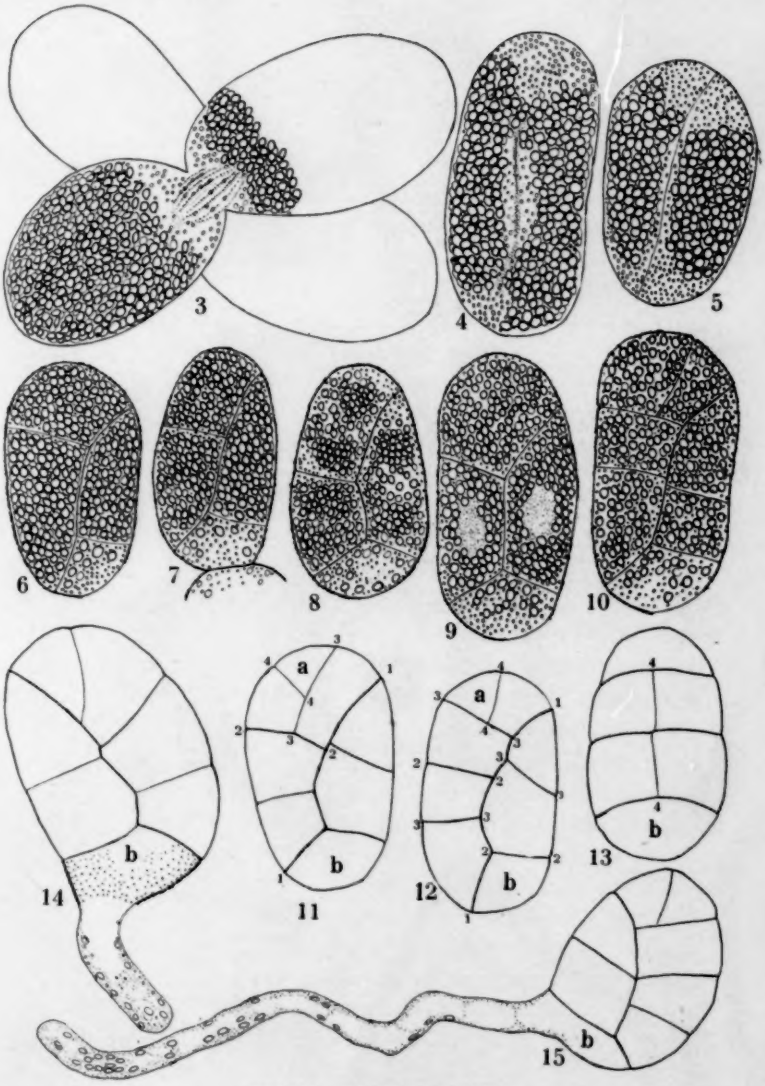
FIGS. 9, 10. Living "spores" from same sporogone grown in greenhouse, examined and drawn Feb. 9, 1924.

FIGS. 11, 12. Outlines of living "spores" from same sporogone grown in greenhouse culture, examined and drawn Feb. 26, 1924, just before the time of dissemination. The line 1....1 represents the plane of the first division; 2....2 that of the second; 3....3 that of the third; and 4....4 that of the fourth division in the terminal cell. The basal cell *b* formed by the second division has undergone no further division.

FIG. 13. Outline of living "spore" from same sporogone as those in FIGS. 11 and 12, "spore" rotated 90° showing fourth division in cells of median portion.

FIG. 14. Living "spore" after twenty-five hours in water culture. The basal cell (*b*) has begun to elongate to form a rhizoid.

FIG. 15. Living "spore" after fifty-four hours in water culture.



PELLIA FABBRONIANA

UNIV. OF MICH.

Anomalies in maize and its relatives—III
Carpellody in maize

PAUL WEATHERWAX

(WITH TEN TEXT-FIGURES)

Two strains of corn, received in the spring of 1923 from P. C. Mangelsdorf, have a type of "defective" grain whose morphology has apparently not yet been described. The anomaly originated independently in two inbred lines of ordinary field corn, and is inherited as a recessive plant character. Two generations of plants have been grown from these seeds, and all evidences indicate that the peculiarity is due to the metamorphosis of rudimentary stamens of the female flower into imperfectly formed pistils.*

FIG. 1. An ear of maize with "defective" grains, × ½.

The resulting structure has the appearance of a very slender grain of the "shoe-peg" type (FIGS. 1 and 2). At maturity it resembles the empty shell of a small normal grain; but examination during development shows merely a lateral sinus, and no true ovarian cavity formed by infolding or invagination (*OS*, FIGS. 4–6 and 10). The enclosed cavity (*SC*, FIG. 10) is formed by the breaking down of the parenchyma of the interior late in development. The ovary-like portion is surmounted by a style, often as much as 8 or 10 cm. long. The distal portion of this style is stigmatic and often simple in structure, having but a single vascular strand and ending in a single tip. Its basal portion, however, is usually duplex in structure, like a normal "silk" (FIGS. 8, 9). Whether or not this indicates a homology between this organ and the

* This occurrence is commonly known as *pistillody*, but *carpellody* seems to be a better designation, at least in this instance. See Worsdell, W. C. Principles of plant teratology **2**: 182–186. London, 1916.

normal style is not evident at present. This style is often accompanied by one or more, shorter, filiform appendages without vascular bundles or stigma hairs (*L* and *LL*, FIGS. 7 and 8).

In most of the cases examined only one of the lateral rudimentary stamens was metamorphosed (FIGS. 4, 5); but in a very considerable number both were affected (FIG. 2), and in a few

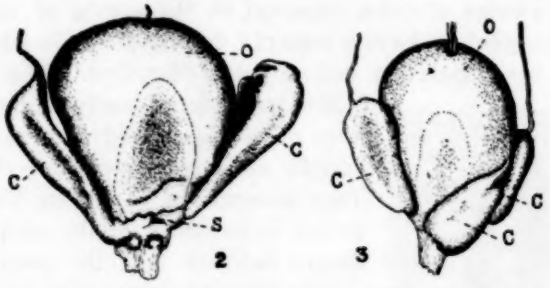


FIG. 2. Mature normal grain with two "defective" grains, × 5.

FIG. 3. Flower with three carpellodia, near the time of fecundation, × 12. *O*, ovary; *CC*, carpellodia; *S*, dorsal rudimentary stamen.

flowers the dorsal member also (FIG. 3). In no case observed was the dorsal stamen alone metamorphosed. Spikelets showing all these degrees of metamorphosis of the rudimentary androecium were commonly associated on the same ear with numerous spikelets having normal pistillate flowers (FIG. 1).

These transformed structures seem to be stimulated to full development by fecundation in the ovary at whose base they are attached. None have been found except in the upper (functional) flower of the spikelet. They approximate normal grains in length only when fecundation has occurred and a normal seed has developed in the ovary of the same flower. This indicates that pollination has an essential but indirect effect in the development of the anomaly.

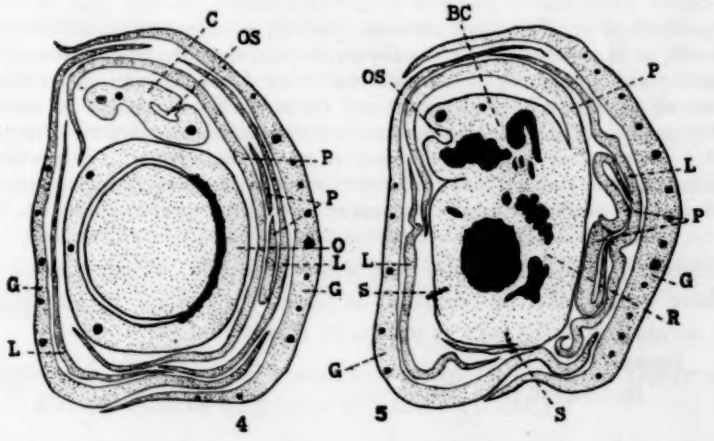
No attempt has been made to pollenize the "silks" of these supernumerary carpels; and, because of their structural limitations, it was obviously not necessary to subject the fully developed "defective" grains to germination experiments.

A case similar to this, but in the wheat plant, has been reported by Leighty and Sando.* Here the character is ap-

* Leighty, C. E. and Sando, W. J. Pistillody in wheat flowers. Jour. Hered. **15**: 263–268. *f. 15, 16.* 1924.

parently not hereditary. Otherwise the two characters are much alike, in so far as they have been examined, even to the duplicate nature of the style in some cases, and the indirect influence of fecundation.

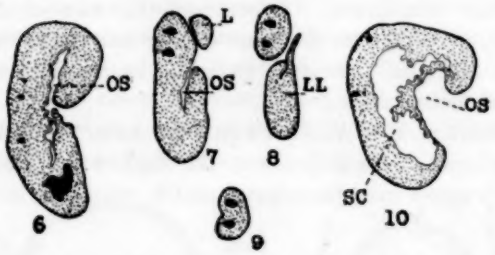
In the light of Miss Walker's theory* as to the constitution of the gynoecium of some grasses, the failure of these modified organs to develop into functional pistils might be attributed to



FIGS. 4 and 5. Transverse sections of a pistillate spikelet, having one carpellodium, × 15. FIG. 4 is through the upper part of the ovary; FIG. 5 is through the receptacle of the flower. *GG*, glumes; *LL*, lemmas; *PP*, paleas, that of the lower (aborted) flower being two-lobed; *O*, ovary of the functional pistil; *C*, carpellodium; *BC*, base of carpellodium at place of attachment to receptacle; *OS*, ovarian sinus; *R*, receptacle of flower; *SS*, positions of the two unchanged rudimentary stamens. The vascular tissue is shown in black.

the fact that they consist of single carpels, while the true pistil is tricarpellary. But this would not explain the carpellodia in maize having duplex styles, or those in wheat having two styles. It was thought that in maize the duplex carpellodia that occur might be the result of the fusion of pairs of organs in development; but in every such case examined, the other two stamens could be accounted for (*SS*, FIG. 5). Therefore, unless the

* Walker, Elda R. On the structure of the pistils of some grasses. Univ. Nebraska Studies **6**: 203-218. *pl. 1-5*. 1906.



FIGS. 6-9. Transverse sections through a carpellodium at different levels, × 15. FIGS. 6 and 7, the lowest sections, show the ovarian sinus, *OS;* FIGS. 7 and 8 show the formation of two lobes, *L* and *LL*, the former disappearing below the level of FIG. 8, and the latter below the level of FIG. 9. The section of the stylar portion (FIG. 9) is almost indistinguishable from that of a normal style. FIG. 10. Transverse section of a matured "defective" grain, × 15. The cavity in this structure, *SC*, is schizogenous in the parenchyma; the ovarian sinus, *OS*, corresponds to the true ovarian cavity.

double vascular systems and other duplex characteristics of these carpellodia be regarded as false suggestions of homology, a serious inconsistency is yet to be eliminated.

INDIANA UNIVERSITY,
BLOOMINGTON, INDIANA

INDEX TO AMERICAN BOTANICAL LITERATURE
1920–1925

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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